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TITLE OF THE INVENTION

Method for Interactive Television Using Foveal Properties of the Eyes of Individual and Grouped Users and for Protecting Video Information Against the Unauthorized Access, Dissemination and Use Thereof

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Method for Interactive Television Using Foveal Properties of the Eyes of Individual and Grouped Users and for Protecting Video Information Against the Unauthorized Access, Dissemination and Use Thereof

BACKGROUND OF THE INVENTION

Fields of the Invention

The invention belongs to the fields of radio electronics, communications, information technology, television, interactive television, industrial and medical television, videophone and videoconferencing.

Art of the Invention

Interactive television features an operation sequence designed to form a video image corresponding to the expectations of the users. The interactive television combines the following operations:

a) video signal preconditioning and formation,

b) video signal conversion,

c) transmission of video signals,

d) video imaging by means of a screen of the information display facility,

e) formation of interrogation signals for data formation, conversion and/or information display facilities.

Eye foveal properties are used for reducing an excessive video image by way of reduction of the spatial, color resolution characteristic of the video image or its parts, as well as by

using the resolution characteristic versus the time of the image display to the user according to the function of his eye resolution.

The eye faculties are widely studied in medicine and are described as the function of the eye resolution threshold. They are used for the diagnostics of eye and the entire body diseases. Development of sensor technique level and identification of the eye dynamic characteristics for the time being in IPC A61B 3/14 class is represented by a variety of devices and methods for determining: coordinates and orientation of the user's eye, their accommodation, eye apple diameter and eye winking factor (invention of the USSR No. 145303, 1960, patents of the USA Nos 3507988, 1970, 04397531, 04720189, 04729652, 04946271, 04973149, 05430505, 05583795, 05649061), which is used for a while only in aviation and in military technology.

Eye dynamic characteristics comprise coordinates and directions of eye optic axes, accommodation, convergence, eye apple diameter and other characteristics. The eye static characteristics comprise long-time characteristics associated with eye individual features (shortsightedness, astigmatism, daltonism, etc.) and affecting the function of the eye spatial, time and color resolution threshold versus the azimuth and elevation angles with respect to the eye optic axes.

Analogues describe proposals for using spatial resolution

dependences of the azimuth and elevation angles of video image area relative to the eye optical axis in the facilities of the formation, conversion and transmission of video signals, as well as in the information display facilities.

Thus, patent of the USA No. 04028725 "High - resolution vision system" proposes the facility, which consists of the facilities of video signal formation presented as sensitive-to-image sensors (TV cameras) and information display facility presented as a display mounted on the user's head. This facility uses eye faculty, which reduces spatial resolution of the video image formed on the screen of the users' video display facility from the line of vision to the sight periphery. This function is realized by the facilities of video signal formation consisting of two TV cameras with a wide and a narrow fields of vision. Video signals of high and low spatial resolution are formed in a TV camera with a double concentric field of vision. Video signals are transmitted via data channels to the video display facility provided with two cathode-ray tubes, which jointly with the optical system generate the video image: wide - with low resolution and narrow images - with high resolution. An optical servo-operated mechanism coalesces these two images and dynamically co-locates the image center of high resolution with the optical axis of the user's eye. The optical servo-operated mechanism contains an optical sensor, using for determining the

dynamic sense of the user's eye optical axis and generating control signals coding the sense of the eye optical axis. The above signals are fed via the data channel to the TV cameras, which according to the interrogation signal modify the orientation of the optical axis of the TV camera of high resolution. In such a way, the user's eye always looks at image of high resolution in the display screen. The device allows using a binocular mode. It also allows using a computer inputs connected to the display or from, sensors or using videotape. This solution permits to process the image presented for one user.

The patent of the USA No. 04348186 "Pilot helmet mounted CIG display with eye coupled area of interest" is interesting by the fact, that it measures the user's head and eye position using head-mounted facilities of formation of high resolution video image, makes a projection of the sector of high resolution video image to cockpit canopy and reflects its motion. The proposed facility fits only for individual usage, because it operates determining one eye area of interest. In the simulator, proposed by the American authors, it is offered to form video image sectors as a series of concentric rings of different ranking such as to present more in detail sectors of central rings, than periphery rings, i.e. with radial reduction of the spatial resolution.

Patent of the USA No. 04479784 "Momentary visual image apparatus" develops the patent of USA No. 04348186. The above technical solution differs in that the coordinates of the line of eye vision are used for the dynamic determination of the foveal field size of the eye high resolution, with the creation and shift of this area of video image sectors with high quality level on the screen, which occurs faster than saccadic eye movements. It is also proposed to synchronize facilities of image display of low resolution with facilities of projection of high-resolution image by the azimuth and elevation angles. According to one of the proposed variants it is proposed to mount the eye position sensor on the helmet.

In a separate claim of this patent it is proposed to provide an electronic fusion of the image sectors of two resolutions. The difference between the facility and the system consists in the fact that the boundaries of the image sectors are not subject to the dynamic adjustment, but only may be shifted from one vision point to another vision point with a high speed. The size of sectors is assigned by the projection facilities of high-resolution images to place the projection of the foveal area into the image of high resolution, whereas the facilities of low resolution generate the image, which surrounds the above image of high resolution.

The distinctive feature of the above invention consists in

the availability of only two sectors with different resolution. At that, the boundaries of the sectors do not modify the form, and every sector features permanent resolution.

USA patent No. 04634384 "Head and/or eye tracked optically blended display system" describes the design of the display generating an image with the resolution corresponding to the spatial position of foveal area of the observer's eye.

The above system and the USA patent No. 05808589 "Optical system for a head-mounted display combining high and low resolution images" has only two areas. The boundaries of these areas are constant respectively, the field of its application is very narrow - flight simulators with dome-shaped screens.

USA patent No. 05808589 and other similar devices helmet-mounted information display facilities, where the image is formed for each eye separately. The sectors of low-and high-resolution images are combined in a device by using a single a facility. The above device is provided with two displays: with high and low resolution, accordingly, and the optical system, generating the single image consisting of the sectors with different resolution and permanent boundary between them. The proposed boundary should correspond to the projection boundary of the foveal field of the eye retina to the screen.

USA patent No. 05980044 "Area of interest display system with image combining using error dithering" developing USA patent

No. 05326266 provides a two-display system of low and high resolution, as well as the facilities of their combination, in particular, the methods of combining two images. In this connection, it is proposed to take into account the current position of the user's eyes.

USA patent No. 04513317 "Retinally stabilized differential resolution television display" proposes to use eye foveal faculty in the TV-display creating two zones in the screen: with high and low resolution in image sector raster scanning. The facility is furnished with a special video camera generating two sectors of high and low-resolution image with their mutual positioning depending on the eye position. In this connection, the best ray of the cathode-ray tube determines the high resolution capacity and vice versa, the worst ray of the cathode-ray tube determines the lowest resolution.

The disadvantage of this method consists in the impossibility of its use for long distances and/or for several users simultaneously.

Eye foveal faculty is also used for the reduction of the bandwidth of the video information channel, for example in the USA patent No. 04405943 "Low bandwidth closed loop imagery control and communication system for remotely piloted vehicle". The system is designed for the reduction of the bandwidth in the "closed video line" and the communication system for the control

of a remotely flight vehicle.

The devices consists of two parts:

- remote part comprising a digital camera, video memory, receiver and video memory reader with different resolution;
- local part comprising facilities for interrogation signal generation and facility of the above data transmission to the unpiloted flight vehicle.

All these facilities and methods are characterized by the individual nature of their use in aircraft simulators, systems of industrial or military purpose. Absolute majority of the considered technical concepts are designed for the service of one eye of the user, in rare cases - two eyes of one user. Anyway, the application a priori presumes, that the distance from the source of video information to the user will be minimized. It is restricted by the period of the data signal transmission via the data channels from the user to the source of video information and vice versa. It should be smaller than the period of the eye optical axis shift from one pixel to the other pixel of the video frame perceived by the user. Otherwise, video image defects will be observed at the boundary of the video image sectors at the turn of the user's eye optical axis. An on-line communication line should be organized for the transmission of interrogation signals coming from the information display facility to the source of video information.

To prevent the degradation of visual perception of video image because of spotting the boundary effects with the user's eye, some patents, e.g., USA patent No. 05071209 "Variable resolution nonlinear projection system" proposes to abandon distinct boundaries of video image, and instead of this to create the image with gradually variable pixels, the size of each of which corresponds to the dependence function of the eye resolution. In case of the fast eye movement any defects at the boundary between sectors of different quality level of the image will be smeared on a wide surface and will not be perceived with the user's eye or easily removed.

For using eye foveal faculties of a group of users, USA patent No. 4859050 1989 described the "Method and system for formation of a visual presentation and looking viewers". According to this method a video film is shot in advance and is recorded on high-quality equipment for its further presentation on the TV-screen. There is a man in front of the screen, who watches the performance. A sensor controls the man eyes which determine the coordinates of the eye optical axis crossing with the screen. A computer converts the sensor data, calculates the objects presented on the screen at the given instance, which the viewer watches, and presents the image of these objects of the screen looking at by the viewer on the graphics. Further using the second graphics video cameras and optical device add signals

of the original performance and graphics. The output signal from the video camera is recorded to a second tape of the second video recorder of standard quality. Insignificant elements of the image in the expert opinion are removed from the second tape. The above method allows using averaged grouped foveal eye faculties. However, it insufficiently reflects individual faculties of an individual user. The proposed method has a feature, which makes it unfitted for interactive television, i.e. the absence of dynamism.

Russian Federation patent No. 2134053 "Method of video information presentation and facility for its performance" describes formation of signals coding boundaries of the image sectors and quality level within each sector based on the coordinate data and user's eye orientation, the signals are supplied to the information display facility in information formation facility with conversion of the initial video signal and management of video image such, that the ecological restrictions on the creation of video image are being reduced. This invention takes into account eye foveal faculties and forms video image in the information display facility. This invention allows using eye foveal faculties of an individual user and a group of users gathered in front of one screen of the information display facility.

The above methods and devices do not allow generating,

transforming or displaying video information taking into account individual peculiarities of the user's eye and individual peculiarities of a group of users' eyes.

Summary of the Invention

Unlike known to the authors' technical concepts, which solve separate tasks at stages of formation, transmission, conversion of the video signal and display of video information taking into account individual peculiarities of the user's eyes or individual peculiarities of a group of users' eyes, the proposed method provides simultaneously all or, at least, two operations from the above operations of formation, conversion and transmission of video signal and display of video information perceptible on the screen of information display facilities for one and/or a group of users or an unrestricted group of users.

The method of interactive foveal television for individual and grouped use is intended to obtain the following technical result for a user and a group of users:

1) reduction of consumed computing power of video signal formation facilities;
2) reduction of the required traffic of the data channel for the video signal transmission;
3) reduction of total computing power of video signal converting facilities and number of operations of video

signal conversion;

4) reduction of the quantity of data channels for the interrogation signal transmission;

5) reduction of the required traffic of data transfer channel for the interrogation signal transmission;

6) reduction of the required quantity of sensors for eye faculties measurement;

7) compatibility of "new" TV standards and "existing" data transfer channels of video information transmission and TV standards;

8) possibility to work at long distance from the source of video information to the display facility;

9) increase of ratio of useful video information volume to the total volume of video information;

10) reduction of the excessive volume of video information during its formation, conversion, transmission and display for a user or a group of users;

11) amelioration of subjective estimation of video image quality by the user;

12) reduction of the negative factor impact to the users' health at the video information perception;

13) protection of video information against non-authorized access, distribution and use;

14) reduced requirements for the power (channel maximum traffic)

of channels of video information transmission and computing power of conversion facilities;

15) provision of individual and grouped users with video information with minimal requirements for information display facilities.

The above technical result is achieved by the method of interactive television using eye foveal faculties of an individual user and a group of users, which consists in the following:

1. The video signal formation facility generates the video signal of the entire video image or video signals of sectors of the video image with one or different quality levels (A): at least one video signal is converted at least one time in one video signal conversion facility (C) into a series of video signals of video display sectors and/or the level of video image sectors (C1-1) is converted, and/or boundaries of video image (C1-2) are changed, all video signals are transmitted via data channels, at least, to one conversion facility and, at least, to one information display facility (B), video image (D) is formed on the screen of the information display facility, which is perceived, at least, by one user (E), characteristics are determined, at least, by one sensor at least for one eye of the user with respect to the video image formed by the information display facility, and signals coding characteristics are formed

dynamically, at least, for one eye of the user (N), the above signals (O1) are transmitted, at least to one computing facility, taking into account the function of the eye resolution (L), interrogation signals coding information on the boundaries are generated, at least, in one sector of the video image (K1) and/or quality levels, at least, video image of one sector (K2) at least for one eye, at least, one user (K1-1, K2-1) and, at least, one group of users' eyes (K1-2, K2-2) are transmitted, at least to two facilities for the given forming facility (O2-1), video signal conversion facilities (O2-2) and information displays facilities (O2-3), in which the interrogation signal is taken into account with respective formation of video signals (?2), with conversion of video signals (C2) and formation of video image (D2).

2. In case of a group of users perceiving a video item, reduction of the negative factor effect on the users' health at the video information perception, protection of video information against non-authorized access, distribution and use for the reduction of the excessive volume of video information by way of use of data on individual peculiarities of the users' eyes, as well as for the amelioration of subjective estimation of video image quality by the user and increase of the ratio of the volume of useful video information to the total volume of video information at the formation of interrogation signals, we propose

a method of claim 1, according to which the computing facility generates an interrogation signal for a group of users, which differs by the fact, that interrogation signals for the users and/or groups of users taking part of the above group, are summarized.

3. For the same purpose, as given in method 2, but for use of interrogation signals coding boundaries of video image sectors, we propose the method of claim 2, which differs by the fact, that interrogation signals coding external boundaries of video image sectors of the similar quality level are summarized for each level of video image quality coded in a series of interrogation signals for a group of users; in this connection, for each interrogation signal the external boundary of the video image sector of each quality level comprises external boundaries of all video image sectors with indicated quality level.

4. For the same purpose, as in method 2, but for use of interrogation signals coding quality levels of video image sectors, we propose the method of claim 2, which differs by the fact, that interrogation signals for the indicated users' group coding the quality level of video image are summarized for each sector of video image coded in a series of interrogation signals for a group of users; in this connection, the quality level of each sector of interrogation signal video image for a group of users is taken as having the highest quality level for the

corresponding sector of video image of each interrogation signal of users or a group of users forming a part of the given group.

5. When quality levels for video signals are standardized that to simplify video signal conversion process in conversion facilities, to protect video information against non-authorized access, distribution and use, to decrease the requirements for the channel power (for the channel maximum traffic) of video information transmission facility and computing power of conversion facilities, to provide individual and grouped users with video information with minimum requirements for information display facilities, to provide the compatibility of the "new" TV standards with the "existing" data transmission channels and TV standards, we propose the method of claim 1, or claim 2 or claim 3 or claim 4, which differs by the fact, that a series of video signals of the entire video image of high and low quality level of video image are formed in the facility of video signal formation, boundaries of each sector of video image are changed in the facility of video signal conversion except for the sector of video image of the highest quality level such that the internal boundaries of the above sector correspond to the external boundaries of the video signal area with a higher quality level of video image with respect to the sector with variable boundaries.

6. In case that a video signal of the initial video image is

received from the facility of video signal formation of the same quality level, we propose the method of claim 5, which differs by the fact, that a video signal of the entire video image is converted into a series of video signals with quality level of the video image, with the lower quality level of the video image of the initial video signal.

7. According to methods 5 and 6 video signals of all quality levels, except for the lowest level, with sequential conversion and transmission from video signal formation facility to the information display facility, reduce their area, whereas the sector of video image with the lowest quality level throughout the above conversion increases its area, covering in the information display facility the area of video image achieving the level of 90 - 99%. With a view to reduce the required traffic of the information channel for the transmission of video signals, to increase the ratio of the volume of useful video information to the total volume of video information, we propose the method of claim 5 or 6, which differs by the fact, that the video signal of the lowest quality level of video image is transmitted via the data channels of data transmission facility to every facility of information display directly or via the facility of video signal conversion, associated with the relevant information display facility.

8. In the case that levels of video signal quality of low and

high quality levels are characterized by the fact that an element of video image (e.g., pixel) of the video signal of low quality covers the whole quality of video signal elements of high quality level, with a view to reduce the required computing power of video signal formation facility, to reduce the aggregate computing power of video signal conversion facilities and the quantity of operations, we propose the method of claim 5 or 6, or 7, which differs by the fact, that the video signal of the entire video image or sectors of the video image of low quality level formed in the device of video signal formation, in this connection, the value of the pixel of the video image of low quality level is identified as the mean value of video signal pixels of high quality level of the video image, forming a part of the video image sector, restricted with boundaries of the above pixel (A4. C8).

9. For decreasing the requirements for the channel power (maximum traffic) of video information transmission facility and for the computing power of video signal conversion facilities, for simplicity of computing in the video signals conversion facility, we propose the method of any claims 5-7, which differs by the fact, that the video signal is converted into the low quality video signal in the facility of video signal conversion, in this connection, the pixel value of video signal of low quality video image is determined, as the value of one of pixels

of the video signal of high quality level of video image, forming a part of video image section restricted with boundaries of the above pixel (A5. C9).

10. In case that quality levels for video signals are standardized by a series of quality levels, comprising the lowest quality level and a series of higher quality levels with respect to it, that to reduce the volume of the transmitted information and to reduce the requirements for the computing power of the conversion facilities, as well as to protect video image against non-authorized access, distribution and use, we propose the method of claim 5 or 6, or 7, or 8, or 9, which differs by the fact, that a video signal of the first extended quality level in the facility of video signal formation or in the facility of video signal conversion respectively is formed by the subtraction from the video signal of the first high quality level of the video signal of the basic quality level, whereas the video signal of the second and the further extended quality levels is formed by the subtraction from the video signal of the relevant high quality level of the video signal with the quality level reduced with respect to it respectively; in this connection, the lowest level of video signal quality is the basic level of video signal quality in the conversion facility of video signals connected with the information display facility for every video signal, except for an extended video signal corresponding to the highest

quality level of video image within the limits between the external boundary of the above video signal and the external boundary of the video signal with high quality level with respect to the stated video signal; video information of the relevant video signal and video information of all video signals with quality level lower than the stated quality level is summarized, the video signal with a higher quality level is formed by summing within the limits of the boundary of the assigned sector of video information of video signals of all quality levels.

11. For reducing the required traffic of the data channel for transmission of video signals, compatibility of "new" TV standards and "existing" data transmission channels of video information and TV standards, we propose the method of claim 10, which differs by the fact, that the video signal with the basic quality level is formed in the facility of video signal formation and is converted in the facility of conversion into the standard video signal (A6-3. C10-5) and it is transmitted to the information display facilities of the users and/or a non-restricted group of users provided with standard facilities of video information display (B4-1. B4-3).

12. Should the element of video information of low quality video signal of the video information occur to be determined as the average value from video information elements of high level quality video signals covered by the above element of video

information with low quality level (A4. C8), for the purpose of reduction of the volume of video information transmitted through communication channels, we propose the method of claim 9, or 10, which differs by the fact, that the pixel of the video signal of the extended quality level of video image in the facility of video signal formation or in the facility of video signal conversion is determined by subtraction of high quality level pixel of video image (A7. C11); video signal pixel with basic quality level in the facility of video signal conversion or the facility of information display video signal pixel of high quality level of the video image is formed by way of summing the video signal pixel of the extended quality level and the video signal pixel of the quality basic level (C9-2, D3).

13. Should the element of video information (pixel) of low quality video signal occur to be determined as one of pixels of video signals of high quality level forming a part of the video image sector restricted with boundaries of the above video signal pixel of low quality level of video image (A5, C8), for the purpose of reduction of the volume of video information transmitted through communication channels and reduction of volume of computations in video signal conversion facility, we propose any method of claims 6, 9, or 10, which differs by the fact, that the video signal pixel of basic quality level in the facilities of video signal formation or video signal conversion

is determined as equal to the video signal pixel of high quality level forming a part of video signal pixels of high quality level of video image sector, included into video image sector, restricted with boundaries of the above video signal pixel of the basic quality level (A8, C11-1); the other pixels are determined by way of subtraction of video signal pixels with basic quality level from the pixels of high quality level (A8-2, C11-2), video signal pixel of high quality level is determined in the facilities of video signal conversion or information display as corresponding to video signal pixel of the basic level (C11-3, D4-1); the other video signal pixels of high quality level included in the video image sector restricted with the boundaries of the pixel of the relevant video signal of the basic quality level are formed by way of summing the relevant video signal pixels of the extended quality level and the relevant video signal pixel of the basic quality level (C11-4, D4-2).

14. With a view to provide the compatibility of the "new" TV standards and the "existing" video data transmission channels and TV standards, to reduce the effect of the negative factors to the users' health at the simultaneous perception of video information by means of one or different information display facilities, to sum video signals of basic and extended levels in one video image formed in the information display facility, we propose the method of any claims 1-13, which differs by the fact, that the screen is

scanned with an electronic ray in the information display facility using the CRT, video signals coding boundaries of the sector of extended video image are transmitted to the electron gun to the facility of sector output control at the entry of the electronic ray into the sector area with the other quality level, to the control facility of the image sector output with control signal delivery to the change of the size of the luminous spot on the CRT screen to the size corresponding to the size of a pixel of video image of video image sector (D5).

15. With a view to provide the operation for long distances from the source of video information to the video display facility and provision of individual and grouped users with video information at the minimum requirements for the information display facilities, we propose the method of claim 6 or 10, which differs by the fact, that converted video signals of low or basic quality level previously are recorded on video signal medium (A9-1), the video signal of low or basic quality level is displayed synchronously with produced video signals of high or extended quality level accordingly (A9-2).

Brief description of the drawings of the Invention

Fig. 1 Block diagram of the method of foveal interactive television of claim 1. Variant for one individual user included in the group consisting of two users.

Fig. 2a. Video image with one (lowest) quality level.

Fig. 2b. Video image consisting of sectors with different quality levels.

Fig. 2c. Video image consisting of sectors with different quality levels and boundaries, which differ with respect to the video image sector boundaries.

Fig. 2d. Video image consisting of sectors with different quality levels, with boundaries comprising video image quality levels Nos 3b and 3c.

Fig. 3a. Video image consisting of sectors with assigned boundaries and one maximum quality level.

Fig. 3b. Video image consisting of sectors with assigned boundaries and with different quality levels.

Fig. 3c. Video image consisting of sectors with assigned boundaries and with different quality levels, which differ from quality levels of video image sectors.

Fig. 3d. Video image consisting of sectors with the same boundaries that are shown in Fig. 3a, 3b, 3c and with quality levels in each sector not worse than the quality level of sector 4b or 4d.

Fig. 4. Block diagram of the method of interactive foveal television. The users are located in front of several information display facilities.

Fig. 5. Block diagram of the method of interactive foveal

television. Several users are located in front of at one information display facility.

Fig. 6. Block diagram of the method of interactive foveal television of claim 2 with by stage formation of interrogation signal with formation and conversion of boundaries of video image sectors with different quality levels (claim 3).

Fig. 7. Block diagram of the method of interactive foveal television of claim 4 with by stage conversion of quality level of video image sectors.

Fig. 8. Block diagram of the method of interactive foveal television of claim 1. Individual interrogation signals are transmitted to information display facility and facility of video signal conversion connected with it, whereas the grouped interrogation signal is transmitted to the facilities of formation and conversion of video signals to a group of datainformation display facilities.

Fig. 9. Block diagram of the method of interactive foveal television of claim 1 with by stage formation of interrogation signals in individual computing facilities.

Fig. 10. Block diagram of the method of interactive foveal television of claim 1 with by stage formation of interrogation signals in individual computing facilities connected with facilities of video signal conversion.

Fig. 11. Boundaries of video image sectors with quality level is

converted for several times.

Fig. 12. Block diagram of the method of interactive television with a single preliminary conversion of quality level and sequential conversion of sector boundaries of the video image.

Fig. 13. Block diagram of the method of interactive foveal television of claim 5 with conversion of video signals into a high and low quality levels and with low quality level video signal transmission to the standard video display facilities of claim 7.

Fig. 14. Block diagram of the method of interactive foveal television of claim 10 with conversion of video signals into video signals of basic and extended quality levels

Detailed description

1. The method of interactive television using eye foveal faculties of individual and grouped users, which protects video information against non-authorized access and distribution, is presented in detail in the block-diagram in Fig. 1. It presents a variant of interactive television broadcasting for the minimal group of users, consisting of the users of two information display facilities and for, at least, one individual user perceiving a video item in one information display facility. It comprises the following operations:

Ref. 1 - A video signal of video image is formed in the video signal forming facility (A1). Video image corresponding to the formed video signals may consist of one sector with permanent quality level such as in case of traditional television (A1-1-1), e.g., that one, which is conditionally shown in Fig. 2, Ref. 2, or two and more sectors with different quality levels intended for broadcasting to multi-screen information display facilities (A1-1-2), Refs 3,4,5.

Video signals may be formed with constant by time quality level of video image (A121) or have time dependent quality level of video image (?1-2-2).

Quality level of video signal and corresponding to it sector of video image may be presented by the following characteristics or parameters:

- spatial resolution of the coded video image (quantity of video image pixels);
- pixel colored resolution, i.e. number of colors, which may be formed by one pixel of the coded video image;
- number of "gray" tones;
- temporary resolution characterized by the frequency of frame shift within a sector or the time of sector presentation of the video image;
- video image contrast;
- used methods of scalability, such as:

- signal/noise ratio;
- etc.

Video signals are formed with time constant boundaries (A3-1) or with time dependent boundaries (A3-2). In this connection, video signals with the same quality level are formed in different sectors (see also Fig. 3a, Ref. 6) (A1-1-2) or with different quality levels (?1-2-2) (see also Fig. 2b or 3b). Three quality levels conditionally present sectors shown in Figs 2 and 3: the lowest (Ref. 7), the medium (Ref. 8) and the highest quality level of video signals (Ref. 9).

Video signals are formed separately in the facility of video signal formation (A2-3-1), i.e. without any control signals, or by interrogation signals (Fig. 1, Ref. 1), coding quality levels of video image sectors, and/or video signals are formed with variable quality levels within the stated sectors of video image (A2-3-2), and/or video signals with variable boundaries within the stated sectors (A2-2-2) are formed by interrogation signals coding boundaries of video image sectors. Sectors may cover a part of the image, the entire image, completing each other or overlapping each other, as shown in Figs 2e, 2f, 2h (Refs 3, 4, 5).

A video camera may be used as the facility of video signal formation, i.e., a video camera, which is capable to form intercomplementary video signals of different quality levels,

e.g., given in Figs 2a, 2e, 2f, 2h (Refs 2, 3, 4, 5) for video camera, which may change the orientation and/or field of vision when changing the focal depth and/or diaphragm aperture of the video camera objective taking into account interrogation signals coding boundaries of sectors and/or quality level of video signal in the assigned sectors. It is also possible to use a combination of two or more video cameras with different quality level, as in the case of USA patent No. 4028725.

Should the used source of video information occur to be the facility of video signal display, the above facility has the capacity to read off a part of the recorded information by the interrogation signals and to display only those preliminarily distributed while recording sectors of the data medium, which correspond to different sectors of video image and/or different quality levels of the video signal within the boundaries of the above sectors of video image taking into account interrogation signals. Video signals may be formed in computer video facilities forming double sighting information or virtual reality similar to computer games.

Formation of video signals consisting of sectors with different quality level by the programmable method is described in Russian patent No. 021498908 and in USA patent No. 4028725.

The purpose of such division of video image into sectors and reduction of quality level in individual or all sectors of video

image consists in the reduction of the video signal data volume transmitted through data channels and for reduction of the video image data redundancy formed by means of the screen of information display facility.

Ref. 10 - Video signals are transmitted through data channels from the source of video information, which is presented by video signal formation facility or video signal conversion facility, to two or more video signal consumers presented a facility of video signal conversion and, at least, to one datainformation display facilities (B1) respectively, as it is done in case of the network transmission (B2).

Ref. 11 - Video signals are transmitted through data channels from one source of video signals to one consumer of video signals (B2).

Video signals are transmitted to every above facility in the full volume or the video information is transmitted in the reduced volume according to interrogation signals coding sector boundaries of video signals and/or the quality level within the sectors of the video image.

Video signal transmission (Refs 10 and 11) via the cellular network presumes, that the user is network subscriber, so he (she) receives individual video signals or video signals of video image sectors via the established communication channel. When video signals are transmitted from one or group of users through

a transmitter similar to the transmitter provided in the cellular network, all users possessing aerial receivers of the respective range located in the transmitter coverage zone, constitute one group of users. The transmitter transmits all video information ordered by a group of users on the air; video information channels are formed according to individual interrogation signals linked with a particular user, e.g., by way of the transmission of video signal coordinates of the video image sector or decoding keys ordered by the user of the video image sector to the receiver. In case the user does not form interrogation signals, he (she) may receive the entire grouped video signal for the further conversion and/or display of the video signal ordered by a group of users.

Ref. 12 - Video signals with constant sector boundaries and/or with constant quality level within these sectors or by interrogation signals coding video signal sector boundaries and/or quality levels of video signals of video image sectors are converted in facilities of video signal conversion taking into account interrogation signals; incoming video signal is accordingly converted into video signals with variable boundaries and/or with variable quality levels within the stated sectors (C2).

The area of the video image sector is reduced in the facility of video signal conversion at least with respect to one

video signal coming to the video display facility (C1), and/or quality level is reduced with respect of at least one video signal by way of simultaneous reduction of one or several parameters of quality level.

Video signal conversion taking into account interrogation signals is done in one or several stages depending on the number of users provided with the sensors used for the determination of eye characteristics and depending on the extent to which the structure of the users is ramified.

Video signal conversion may be conventionally divided into stages.

The first stage of conversion consists in the conversion by the sum interrogation signal at the level of a town and/or at the level of a region and/or at the level of a residential quarter (other divisions are possible and this is not important), i.e., on the top level of the users' hierarchical scheme.

The further stages of video signal conversion consist in conversion by the sum interrogation signal (received by summing of interrogation signals of individual users and a group of users) at the level of streets, a building and/or a building entrance, which represents the following level of the users' hierarchical scheme of the interactive television.

The last conversion stage is used for the video signal conversion taking into account individual interrogation signals

coming directly from individual users depending on the availability of the data from the users' sensors.

Video signals may be converted in two or more conversion facilities in parallel, e.g., for the users perceiving a video item on different information display facilities (see Figs 2b and 2c) and/or in series, video image with one quality level, Fig. 2a is converted into a video image, Fig. 2d for several users, next the video image is converted into the video image with boundaries and quality levels of video image sectors for a single user (Fig. 2b or 2c).

When video signals are converted in facilities of video signal conversion, the volume of video image video signal information is reduced dynamically. The dynamic reduction of video information volume in the video signal conversion facilities taking into account signals coding user's eyes orientation is described in USA patent No. 4405943. However the above method fits only for individual users.

Ref. 13 - Screens of information display facilities are used for video image formation, which corresponds to incoming video signals. Sectors of video image corresponding to the incoming video signals have boundaries and quality level of video image corresponding to the characteristics of the incoming video signal (D1). The above operation is done using video display facility without taking into account interrogation signals. In this

connection, characteristics of user's eye may not be measured with sensors.

Ref. 14 - When the interrogation signal coding boundaries of video image sectors, comes to the information display facility, and/or when the quality level in the above sectors differs from the boundaries of video signals arrived to the datainformation display facility, video image is generated in the above facility with boundaries and quality levels corresponding to the interrogation signal (D2). The above task may be solved using the datainformation display facility previously proposed by the authors on the basis of CRT, liquid crystal screens, etc., e.g., as described in Russian patent No. 2134053.

Ref. 15 - One or several users perceive the video image formed on the screen of at least one information display facility (E). There may be one, two or more users at one video image as it is shown in Fig. 4.

The quality level of video image or its sector perceived by the user's eye may be presented by the following characteristics or parameters:

- spatial resolution of video image (minimal angle dimension of pixels perceived as separate pixels or maximum number of pixels in a single spherical angle perceived by an eye, as separates pixels);
- colored resolution as per the number of colors, which

may be distinguished by an eye in a single spherical angle;

- number of "gray" color tones;
- time dependent resolution characterized by the frequency of frame shift within a sector perceived by an eye, such as blinking;
- brightness;
- contrast of video image;
- etc.

Ref. 16 - The sensor or sensors are used for the dynamic determination of the eye characteristics with respect to the video image perceived by the user with formation of data interrogation signals coding eye characteristics (N) or eye characteristics of several users as it is shown in Fig. 4, Ref. 25.

As eye characteristics may be used dynamically measured by means of a sensor or sensors: eye orientation, eye coordinates with respect to the video image and other characteristics. In this connection, coordinates of one, two eyes of the user or several eyes or all eyes of users gathered in front of the screen are determined. There is a variant, when every user located in front of the screen is furnished with a sensor. Every eye may be fitted with an individual sensor, e.g., of the helmet type.

Ref. 18 - Data interrogation signals coding eye or eyes

characteristics (Ref. 26) are transmitted at least to one computing facility (O1), in this connection, dynamically changed characteristics such as coordinates and direction of eye optical axes, eye accommodation depth is dynamically transmitted (O1-1), whereas slowly changed characteristics, such as eye apple diameter, function of eye resolution dependence with respect to the eye optical axis are transmitted to the computing facility by periodical or initial entering into the memory of the computing facility (O1-2).

The function of eye resolution dependence is determined as a function of the mode or the type of display information and subjective features of the user.

Ref. 19 - Interrogation signals coding information on the boundaries of at least one sector of video image (K1) and/or on quality level of video image (K2), within which the requirements of the user's or the users' eye perceiving video image are generated by the signals coding user's eye dynamical characteristics taking into account the function of the eye resolution dependence in the computing facility.

When boundaries and quality levels of video image sectors are determined, the task of the minimum video data redundancy is solved by reduction of the video signal quality level down to the minimum level, when the user perceives video image as the real image within the stated eye sectors. Quality level of video image

sectors is minimized and dimensions of video image sectors of high level are reduced at the earliest possible stages of video signal formation, conversion, transmission or datainformation display.

According to the above analogues only one interrogation signal is formed, which is transmitted to the video signal forming facility, video signal conversion facility or to the datainformation display facility (patent of Russia No. 2134053). We propose to generate at least two interrogation signals. Fig. 1, Ref. 20 shows formation of individual interrogation signals for one video display facility; Ref. 21 presents grouped interrogation signals for two or more information display facilities or summed interrogation signals obtained by addition of individual and/or grouped interrogation signals.

Ref. 22 - An individual interrogation signal is transmitted to the information display facility (N2-3) and/or to the conversion facility (O2-2), connected with the above information display facility (O2-1-1).

Ref. 14 - The datainformation display facility shows sectors of the video image taking into account interrogation signals with boundaries and quality level corresponding to the interrogation signal of the datainformation display facility.

At the same time interrogation signals of the datainformation display facility may be transmitted to the video signal

conversion facility connected with the above datainformation display facility (O221), Ref. 23. Boundaries and/or quality levels of video image, Ref. 12 are converted according to the interrogation signals in the conversion facility.

Ref. 24 - The summed interrogation signal is transmitted to the video signal formation facility (O2-2). Video signals of video image sectors with its boundaries and quality levels within the stated sectors corresponding to the requirements of grouped users' eyes perceiving video image (C1, C2) are formed in accordance with the interrogation signal in video signal formation facility.

According to these interrogation signals the video signal sequentially reduces the data redundancy taking into account the requirement of a group of users gathered in front one screen or a group of users, who simultaneously watch video image on many screens. The above group may cover a building entrance, building, a street, a town, etc. The video signal sequentially reduces its redundancy down to the level corresponding to the eye requirement of one individual user taking into account individual faculties of its eye and its demand with the display of video image covering sectors with different quality level on the screen of the datainformation display facility.

A video signal consisting of sectors with boundaries and quality level corresponding to the grouped interrogation signal

(Ref. 13) is formed in the information display facility not taking into account interrogation signals from the video signals received from video signal formation or conversion facilities. According to the patent analogue to USA patent No. 4028725 the provision is made for the formation of the control signals, i.e. signals formed taking into account the properties of the management object: TV camera, computer. In our case, interrogation signals, which characterize faculties of users' eyes, are generated and transmitted.

As a result of the proposed method, one information display facility or a group of information display facilities integrated by the common data channel, e.g., a feeder mounted in the building entrance, receives the summed data signal with the reduced redundancy of video information. Usually the users look at the same video item, therefore there exist a probability, that with the growth of the number of the users being in front of one video display facility, the volume of video information to be transmitted will grow in non-linear dependence or will not be changed, as it is described in USA patent No. 4859050.

In addition, video image with the lowest redundancy is formed for the users, whose eye characteristics are measured by means of sensors, and for whom an individual interrogation signal is generated in the computing facility, whereas a grouped video signal received taking into account summed interrogation signals

comes to the information display facility without of the sensors.

Simultaneous fulfillment of the above operations makes it possible to fulfill the assigned tasks.

All the above characteristics are required and sufficient to solve the assigned task and to achieve the stated technical result.

2. The block diagram of the method of interactive foveal television and formation of interrogation signals in the computing facility by stage is given in Fig. 6. The above method is intended to use the data of eye individual features while generating interrogation signals and to make faster the operation of generation of individual interrogation signals in the computing facility (K1, K2) in case of a group of users perceiving a video item. This method is based on the eye feature, according to which the eye resolution from the vision line to the periphery goes down; consequently, sectors of video image of a low quality level (Ref. 7) cover sectors of high quality level (Refs 8 and 9).

Method 2 differs from method 1 by the following operations:

Ref. 27 (K1-1). Individual interrogation signals coding information at least about one boundary of at least one sector of video image (L1-1) are generated in the computing facility by the signals coding eye dynamic characteristics taking into account the dependence function of the user's eye resolution (K1-1). The

example of boundaries of video image sectors for different eyes for the same set of quality levels is given in Figs 2b and 2c, Refs 3 and 4. The above operation is done for a group of users' eyes with requests to be accounted in the process of the interactive television.

Ref. 28 (K1-2). The interrogation signal for users' groups coding external boundaries of video image sectors of the same quality level (K1-2) is formed in the computing facility by the stated interrogation signals for users and users' groups designed for several eyes and to code boundaries of video image sectors. For this purpose the external boundary of the sector of video image of each quality level comprises external boundaries of all sectors of video image with the above quality level (K1-3). The example of the boundaries of sectors of the video image for the summed request is given in Fig. 2d.

The above method makes it possible to generate grouped interrogation signals corresponding to the requirements of every registered user perceiving a video image.

3. The block diagram of the method of foveal interactive television with sequential conversion of quality levels of sectors of video image is given in Fig. 7. It comprises the operations, which differ from the operations indicated in method 1, which are as follows.

Ref. 29 (K2-1). Individual interrogation signals coding

information on at least one quality level of at least one assigned sector of video image (K2-1) are generated in the computing facility by signals coding eye dynamic characteristics taking into account the dependence function of user's eye resolution (L1). An example of quality levels of video image conditionally assigned by a value from 1 to 3 for one set of sector boundaries of the video image shown in Fig. 3a, Ref. 6, for different eyes is given in Figs 3b and 3c. The above operation is done for a group of users' eyes, whose requests will be taken into account in the process of interactive television (K2-2).

Ref. 30 (K2-2). A sum interrogation signal coding quality level in the sectors of video image with the highest quality level in any stated sector of the video image (K2-2) is formed in the computing facility as per the stated individual interrogation signals designed for several eyes, which code quality levels of video image in the stated sectors of video image. An example of quality levels for the assigned sectors of video image for the sum interrogation signal is given in Fig. 3d.

4. The block diagram of the method of foveal interactive television with formation of interrogation signals by stage and interrogation signal transmission to facilities of video signal formation, conversion or information display of claim 1 is given in Fig. 8. We propose a variant, in which several information

display facilities are used for one video signal formation or conversion facility. This method differs from claim 1 or 2 or 3 by the following operations:

Ref. 10 - Video signals with the same boundaries of sectors and quality levels within the stated boundaries (B) are transmitted to a number of video display facilities.

Ref. 27 or 29 - Individual or grouped interrogation signals of the information display facility coding boundaries and/or quality level of sectors of the video image respectively (K3-1) are generated in the computing facility for one or for a group of users' eyes perceiving a video image (E) on one screen of a video display facility.

Ref. 22 - The above interrogation signals are transmitted to the information display facility or to the video information conversion facility connected with the information display facility (O2-4).

Ref. 28 or 30 - A sum interrogation signal (K3-2) is formed in the computing facility by two or more requests of datainformation display facilities of a group of information display facilities.

Ref. 23 or 24 - Stated interrogation signals of a group of information display facilities are transmitted respectively to the conversion or formation facility connected with a group of information display facilities (O2-5).

Method 1 in the reviewed variant makes it possible to use intermediate signals for the formation of interrogation signals for the information display facility and/or video signal conversion facilities, which saves the time of interrogation signal transmission to the information display facilities and video signal conversion facilities, which are connected with them.

5. To minimize the volume of computations in an individual computing facility with simultaneous reduction of the traffic of interrogation signal transmission and to reduce the number of the data channels for signal transmission from the sensors to the computing facilities, we propose the method with distributed interrogation signal generation in separate computing facilities. The block diagram of the variant of implementation of foveal interactive television of claim 1 is given in Figs 9 and 10.

Ref. 27 or 29 and Ref. 28 or 30 - Interrogation signals are generated according to the proposed method for the users' eyes perceiving video information from one information display facility in one computing facility (K3-1/K3-2). Interrogation signals of the information display facility coding boundaries of sectors and/or quality level in the stated sectors of video image are generated in the above computing facility.

Ref. 31 - Received interrogation signals of information display facility are transmitted to the information display

facility (Fig. 9) or to video signal conversion facility (Fig. 10) connected with the stated information display facility; interrogation signals are also transmitted to the computing facility connected with video signal conversion or formation facility for a group of facilities, which is included into the stated information display facility (O3-1).

Ref. 28 or 30 - A sum interrogation signal of a group of information display facilities (K4) is formed in the computing facility by interrogation signals from a group of computing facilities.

Ref. 32 - A sum interrogation signal is transmitted to the video signal conversion facility or to the video signal conversion or formation facility connected with the above computing facility; interrogation signals are also transmitted to the computing facility connected with the video signal conversion or formation facility for a group of facilities, to which is included the datainformation display facility (O3-2).

The proposed variant of implementation of an independent method makes it possible to separately process signals coming from eye characteristic sensors or interrogation signals received in the previous stages.

6. When an independent method is implemented in case of a bulk network of video signal distribution, it is necessary to convert in parallel quality levels of the same sectors of video image

transmitted to the video signal conversion facilities. When interrogation signals are transmitted from users' information display facilities to the conversion and formation facilities, interrogation signals of video image sectors are summarized in computing facilities. In this connection, video image sectors are expanded as it is shown in Figs 11a, b, c, d. Video signals of video image sectors of high quality level are converted into the video signal of low quality level in every video signal conversion facility, as shown in Figs 11f, g, h which increases the requirements for computation capacity of video signal conversion facilities. The block diagram of the method of foveal interactive television with a one-fold preliminary conversion of the quality level and sequential conversion of sector boundaries of video image, which differs from that one given of claim 1 by the following operations, shown in Fig. 12.

Ref. 33 - A video signal of the video image of low and at least the same high quality level (A3/ C4) is formed or converted in a series of video signals of the video image in the video signal formation facility or in the primary formation facility.

Ref. 34 - A video signal of the assigned quality level with boundaries corresponding to the interrogation signal (C5) is extracted from video signal of the sector of video image corresponding to the quality level in the video signal conversion facility taking into account signals coding boundaries of video

image sectors for every high quality level of video image.

Ref. 10 - Received video signals of high quality levels are transmitted at least to one facility of video signal conversion or one information display facility (B2).

Ref. 11 - Video signals of sectors of video image are transmitted to the facility of video signal conversion (B).

Ref. 35 - Internal boundaries of every sector of video image are converted in the facility of video signal conversion, except for the highest level, according to the external boundaries of sectors of video signals of high quality level for the concerned quality level video signal (C6).

7. Video signals of all quality levels except for the lowest level according to method 5 or 6 reduce their area at the instance of their transmission from the source of video information to the user in the course of the sequential conversion, whereas the sector of video image with the lowest quality level in the datainformation display facility achieves 90 - 99% of video image area. The block diagram of the method with the transmission of video signals of the lowest quality level is given in Fig. 13. The method of claim 6 comprises the following operations, which differ from method 5 or 6:

Ref. 36 - Received video signals of the lowest quality level are transmitted in the full volume to all signal conversion facilities directly connected with the information display

facilities, and directly to the information display facilities.

Ref. 37 - Only video signals of sectors of video image of high quality are transmitted to signal conversion facilities connected with information display facility (B3).

Ref. 38 - Internal boundaries of every sector of video image of low level are converted in the facility of video signal conversion directly connected with the information display facility in accordance with the external boundaries of video signal sectors of high quality level for the given video signal (C7).

Ref. 39 - Video image is formed in the information display facility, and the user perceives it without foveal interrogation signals corresponding to the function of the eye resolution of the individual user.

8. Should quality levels of video signals of low and high quality levels occur to be characterized by the fact, that an element of video image (pixel) of a video signal of low quality level restricts the entire quantity of video signal elements of high quality level of the video image, we propose the method of claim 5 or 6 or 7, which differs by the fact that an element of video information (pixel) of a video signal with low quality level is determined in the facility of video signal formation or in the facility of video signal conversion as the average value of video information elements (pixels) of the video signal of

high quality level comprised in the video image sector restricted with the boundaries of the above pixel of the video signal with low quality level (A4/C8).

9. To simplify computations in the computing facility, we propose the method of claim 5 or 7, which differs by the fact that one of elements of video image (pixel) of high level covered by the above element of video image (pixel) of the video signal of low level (A5/C9) is used as the element of video information (pixel) of video signal of low quality level.

10. The method described in claims 5-9 increases the volume of video information transmitted through data channels of the data transmission facility compared to that one described in method 1, because the video signals with low quality level of video image partly back up video information contained in the video signals of a higher quality level. To overcome this disadvantage we propose the method of claim 1 or 5 or 6 or 7 or 8 or 9, which differs by the fact, that the video signal of the lowest quality level is identified as the basic signal. The video signal of the first expansion level is formed or converted by summation of the basic video signal and the video signal of the expanded quality level so that it could be possible to generate the video signal of the first high quality level. The video signal of the second high expanded quality level is formed or converted by summation of the video signal of the basic level and video signal of the

first and second expanded quality levels.

Methods and facilities of video signal formation and conversion, in which the above conversion is done without interrogation signals, were described. According to the algorithm laid in the formation or conversion facility, the initial video signal is divided into several video signals, which mutually complement each other. It is possible to use the facility of video signal formation similar to that one presented in "Technique used in cinematography and television", 1999, 1 p. 21, "Operating procedures of studio cameras and TV - systems in the age of digital television", Part 2. Camera technique for HDT. L.J. Torp, Sony Corp., whereas the facility of video signal conversion similar to that one described in "Digital processing of TV and computer images" edited by Y.B. Zubarev and V.P. Dvorkovich, Moscow, 1997, in scheme 8.6 coder of video signal presents the process of the initial video signal conversion into video signals with two scales of the spatial resolution: video signal of basic level and video signal of expanded level. For the inverse conversion of video signals provision is made for the conversion in the conversion facility connected with a particular information display facility - decoder, which is used for the summation of video information of the basic video signal and every expanded video signal into the relevant video signals of the assigned series of quality levels for each sector of the

video image. The block diagram of the method of claim 10 is shown in Fig. 1514. It differs with respect to the most similar to it method of claim 5 by the following operations:

Ref. 40 - A video signal is generated in the facility of video signal formation or converted in the facility of video signal conversion into a series of video signals of the video image of the basic or at least one expanded quality level (A 6/C10-1).

Ref. 41- Video information of the basic quality level and expanded quality level (C11) is summed in the facility of video signal conversion to obtain a series of video signals of different quality level.

12. It is convenient to process separately distributed signals by cutting sectors with boundaries assigned by the interrogation signal in the facility of video signal conversion from video signals of expanded level. When signals come to the facility of video signal conversion connected with a particular information display facility, values of video signal pixels are added in the entire video frame or only in the sector of high quality level, for example, as per method K-1, according to which the pixel color grade signal of high level is added, the mean value of color grade of super pixel is multiplied by K, whereas the color grade of the last K- pixel will be equal to the difference between the sum and the product. A similar approach is possible,

when video signals of basic and expanded level differ by ratio signal/noise, frequency of frame change, color grade and other characteristics of the quality level of the video image. It is also possible to use the variant when giving up calculation of sums, products and differences, and the pixel color grade of low level taken as the color grade of one of K-pixels of the initial level to be selected in the specified sequence similar for each group of K-pixels, either in different way or at random. When video signal of high level is summed for the entire video image or only in the sector of high level K-1, a pixel comes from the video signal of the expanded level, whereas one pixel comes from the basic level signal.

13. To simplify calculations, we propose to use the signal of one of pixels of video image of the initial quality level covered by the pixel of low quality level for the formation of video signal pixel of low level.

As an example of the process of video signal conversion of video image of a series quality levels into the basic and expanded quality levels of video signals without taking into account interrogation signals, we propose the method of claim 6 or 9 or 10, which differs by the fact that the signal of quality level lower than the initial signal is generated by way of data summation of several (K) of the nearest pixels of the initial video signal and division of the sum into the number of pixels

into one pixel of the video signal of low level. For example, the color grade of several pixels is added and divided by the number of summed pixels (K). Once all pixels of video signals of the initial level being processed, a video signal of the whole frame of low level and respectively low size is obtained. On the other part video signals of K-1 pixels of the initial level are transmitted to the generated video signal of high level. The similar procedure may be repeated by the number of quality levels of video signals minus 1. The summarized quantity of information for all video signals will not be greater than the volume of video signals of high quality level with boundaries corresponding to the boundaries of the video image.

The video signal of the basic level comes through data channels to all information processing display facilities of users, including the facilities fitted with decoders in synchronism with signals of expanded levels, obtained in the relevant coders. Video information is summed in coders (adders) by sectors of the video image and video signal of the data processing facility consisting of sectors with variable boundaries and different quality level of video image of the stated sectors is transmitted.

The above method may be used jointly with the effective video standards such as PAL, SECAM, NTSC in the event that standard signals distributed in the networks or on air are used

as the basic video signal, whereas expanded signals are distributed through separate data channels.

14. For example, when the interrogation signal is identified at the stage of its formation or conversion, whereas the determined sectors cover the entire frame of the video image, in such a case during fulfillment of the transmission operation it is possible to adjust and contain not all sectors, i.e. only sectors of the highest quality of video image, during operation of the interrogation signal transmission it is possible to adjust and contain not all sectors, i.e. only the sectors of the highest quality of video image so that they could be transmitted in the due time to the information display facilities, which are viewed for the time being. The other sectors, which are either with quality lower than that one of the previous level or with other boundaries, or which are not transmitted at all depending on the load and the state of the data transmission facility, as well as the critical time for transmitting of video image stream with the eventual further recovery of the interrogation signal to the previous level.

In effect having dynamically provided possible or necessary transmission facility capacity, user's service quality it is because an indication with consideration for interrogation signals is introduced.

15. The method of claim 5 or 6 or 10, which differs by the fact

that video signals of sectors of video image are recorded in advance with the initial quality level (A9-1), whereas every sector of video image with the quality assigned by the interrogation signal is displayed in the facility of video signal formation. To do so, video signals of video image sectors with initial quality level are recorded on the medium in parallel with the data record in parallel addresses; several sectors of data medium are read off in parallel in the facility of video signal formation at the time of video signal display with the initial quality level, when displaying the video signals of low level are read off a part of video signals (A9-2) recorded in parallel are read off.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With a view to demonstrate the applicability of the proposed method of interactive television using eye foveal faculties of individual and grouped users and for the demonstration of the achievement of the assigned technical result we shall compare the existing TV method and the proposed method of interactive television using eye foveal faculties of individual and grouped users for the resolution of the task of HD TV broadcasting.

When using the method proposed by the authors let us consider a variant, according to which video signals are formed by means of similar facilities of video signal formation, i.e. HD TV cameras. Video signal of all video images is converted into a

series of video signals of different quality level according to dependent method 5. Let us assign three quality levels: the first one - the lowest quality level of video image corresponding to SECAM standard (625*625 pixels in a frame), first high quality level corresponding to spatial resolution (1250*1250 pixels in a frame), which by 2 times is more than the spatial resolution of SECAM standard, the second high quality level corresponds to the resolution of the compare high definition television (HD TV) (2500*2500 pixels in a frame), which by 4 times more, than the spatial resolution of SECAM standard.

Suppose that the existing and the proposed methods are applied in the following TV system, in which:

- users simultaneously watch video image of the same video item, formed by video display facilities (Refs. 13 and 14);
- at the same time on the average two users watch one information display facility (first level, 2 users);
- every 10 video display facilities are located in one entrance of a building and are connected to one entrance facility of video signal transmission (second level, 20 users);
- every 10 entrance of a building are connected with the common building facility of video signal transmission (third level, 200 users);

- every 10 buildings are connected by data channels with street facilities of video signal transmission (4th level, 2,000 users);
- every 10 streets are connected by data channels with video signal transmission facilities of residential quarters (5th level, 20,000 users);
- every 10 residential quarters are connected by data channels with regional facility of video signal transmission (6th level, 200,000 users);
- every 10 regions are connected by data channels with the urban facility of video signal transmission facility (7th level, 2,000,000 users).

Assume, that in case of the both TV methods the users are located at a distance of 3 m from the screens located in the perpendicular plane to the eye optical axis and have the size of diagonal 57 cm with side ratio 3 to 4. Taking into account the function of a sound eye resolution, the projection diameter of the foveal area to the video image with the spatial resolution on the external boundary corresponding to the resolution of the TV video signal of the lowest quality level will not be higher than 128*128 pixels, whereas that one of the second high quality level will not be higher than 64*64 pixels. Spatial resolution of the video image formed in the information display facility of transmitted video signal for the both considered methods in an

sector with diameter 1 cm will be lower than the spatial resolution of the user's eye. Thus, both methods form video images of similar pectoral quality level.

Let's identify the volumes of information of video signals transmitted through data channels from facilities of video signal formation to information display facilities according to the existing method of the cabled TV broadcasting.

Number of lines, pcs	2,500
Number of pixels in a line (number of columns), pcs	2,500
Volume of video information of one pixel, byte	2
Volume of video information of one frame, Mbytes	12.5
Image frequency, frame/s	24
Volume of video information transmitted through every data channel of HD TV, Mbytes/s	300
Length of a TV channel from the information display facility to the access TV channel, m	10

Data channels of the lowest level are connected to the data channels of an entrance of the building, a building, a street, a residential quarter, a region or a town in an arbitrary point.

length of a TV channel of an entrance of the building	50
building	200
street	1,000
residential quarter	3,000

region	5,000
town	10,000
The aggregate traffic of data transmission from the entrance TV channels to the information display facilities, Mbytes*km/s	3,000,000
The aggregate traffic of data transmission in all in-entrance TV channels, Mbytes*km/s	1,500,000
- in-building,	600,000
- in-street	600,000
- in-quarter	150,000
- within a region	45,000
- in-town	30,000
The aggregate traffic of data transmission through all data channels of HD TV, Mbytes*km/s	5,508,000

Let's determine the volume of information transmitted through the data channels in the TV broadcasting system according to the methods proposed by the authors.

Unlike the existing method of TV broadcasting, the method proposed by us additionally provides the dynamic feedback of quality level control in video image sectors for individual and grouped users. Let's determine the volume of information of interrogation signals transmitted through data channels.

When the stated method of claim 1 is used, sensors connected with information display facilities determine eye dynamic

characteristics with respect to the video image formed by this information display facility (Ref. 16)(N). For example, signals and their coding signals are dynamically formed as described in Russian Federation patent No. 2134053 using coordinates and orientation of eye optical axes with respect to the video image formed by the information display facility using the method and facilities described in the USSR patent of 1959 and further USA patents of 1983 and more recent patents. Signals coding eye coordinates with respect to the video image are dynamically transmitted to the computing facility (Ref. 18)(O).

The signals coding boundaries of video image sectors of the first high quality level and the second high quality level (Ref. 27) (K1-1) are generated in the computing facility according to method 3 for each eye taking into account the dependence function of the eye resolution (K). For instance, the boundaries may be assigned by the coordinates of centers (Fig. 2, Refs 45, 46, 47, 48) of a broken line (Ref. 49) enveloping a sector of the first increase quality level of the video image (Ref. 50). Coordinates of the points are assigned in the coordinate system connected with the boundaries of the video image sector of the lowest quality level by natural numbers within the range of 1-625. In this case, the accuracy of the boundary identification is equal to the resolution of the lowest quality level and, consequently, an eye cannot distinguish this boundary. The first point (Ref.

45) is assigned by two coordinates X1 and Y1, in aggregate with 22 data bits. The coordinates of the second point (Ref. 46) may be assigned by the value of coordinate Y change. When shifting from the point Ref. 45 to the point Ref. 46, the second coordinate is not changed. The coordinate of the third point is assigned by the value of change of coordinate ?X when shifting from point Ref. 46 to point Ref. 47. In this case coordinates Y are not changed. On the basis of the geometric features of a rectangle, the forth point of the boundary between the sector of the low quality level and the sector of the first high quality level is plotted.

Assigning the highest size of the sector of the first high quality level to horizontal ?? and to vertical ?Y up to 128 $=2^7$ pixels of the video image of low quality level, in order to assign coordinates of the second point and every further point, 7+1 data bits will be required. Coordinates of the broken line (Ref. 49) comprising the sector of video image of the first high quality level (Ref. 50) will be assigned fully, when the coordinate of the further point will coincide with the coordinate of the initial point (Ref. 46). Let's assign the simplest form of a broken line comprising a sector of video image of the first high level, i.e. a rectangle; in this connection the aggregate interrogation signal of the first high quality level of one information display facility to one eye will be 22+2*8=38

bits/frame/eye.

Having assigned coordinates of the first point (Ref. 51) of a broken line (Ref. 52) comprising a sector of the second high level with respect to the first point of the first broken line (8+8=14 bits/frame), and assigned maximum size of the sector of the second high quality level to horizontal and to vertical, which do not exceed 64 pixels of video image of lower level, the interrogation signal coding boundaries of the video image sector of the second high level for one eye will be equal to 14+2*6=28 bits/frame/eye.

The interrogation signals coding boundaries of video image sectors of the first and the second high quality level for the user's eye will not exceed 24*(38+16)=1296 bits/s for information display facility used for one user with the frame frequency of 24 frames/s.

Then, an aggregate interrogation signal (Ref. 28) (K1-2) coding boundaries of video image sectors of the first quality level for the case, when projections of eye optical axes of two users are distributed over the video image surface with the same probability, is generated in the computing facility according to method 2, covering boundaries of sectors of the first high level of video image of every eye perceiving a video image.

For the frequency 24 frames/s interrogation signals coding the boundaries of video image sectors of the first and second

high quality levels of one information display facility for four eyes will be equal to 4*1296/8=648 bytes/s.

According to method 5 the interrogation signals generated for one eye or for several eyes of users (Fig. 9, Ref. 27/29 or 28/30) are transmitted to the information display facility and to the computing facility of a higher level (Ref. 31).

Let's calculate the maximum size of the interrogation signal generated for the urban facility of video signal formation according to method 4. Let's determine the number of video image sectors equal to the number of pixels of the video image of the lowest quality level. In this case:

Number of quality level, pcs	3
Number of bits for assigning quality level of one pixel, bit	2
Frame frequency, Hz	24
Volume of quality level interrogation signal of video frame sector, Kbytes/s	2,343

The calculated interrogation signal for all users of a town will have the maximum value. We calculate interrogation signal traffic transmitted through the data channels for intermediate levels taken as reference an exponential growth of the interrogation signal traffic of the number of users' eyes.

The peculiarity of the proposed method consists in the fact that the data channels of interrogation signal transmission of

each level are connected into a "star".

Length of TV channel from the information display facilities to the entrance computing facility, m	60
building	200
street	1,000
residential quarter	5,000
region	10,000
town	15,000

The aggregate traffic of interrogation signal transmission through all data transfer channels from every information display facility to in-entrance computing facilities, Mbytes*km/s	15.23
- in-building	19.89
- in-street	38.97
- in-residential quarter	76.34
- within a region	59.82
- in-town	35.15
The aggregate traffic of interrogation signal transmission according to the proposed method amount to, Mbytes*km/s	245.4

Let's determine the volume of video information transmitted through the data channels from the facility of video signal formation to the information display facilities in accordance with the stated method. According to method 10 video signals:

are formed and/or converted into video signals: of the basic level, the first expanded level, the second expanded level.

The volume of the video signal of the basic quality level according to the proposed method of claim 11 corresponds to the method of SECAM video signal transmission and corresponds to 1/16 of the volume of HD TV signal.

The aggregate traffic of video information transmission of the video signal of basic quality level SECAM for all in-entrance TV channels, Mbytes*km/s	187,500
- in-building	112,500
- in-street	18,750
- in-residential quarter	5,625
- with a region	938
- in-town	188
The aggregate traffic of video information transmission for all data channels of HD TV, Mbytes*km/s	344,250

According to the stated method 11 the structure of video signal distribution of expanded quality levels corresponds to the above-considered structure of interrogation signal, and the structure of video signal distribution of basic quality level corresponds to the structure of HD TV distribution structure.

Let's determine the traffic of video information of the first and second expanded quality levels to be transmitted to one information display facility of the stated method taking video

image sector shape as rectangular and the number of eyes simultaneously perceiving the video image formed by one screen of the information display facility as equal to 4 (two users watch video item simultaneously).

Volume of video information of one frame of video signal window of the first high quality level, bytes	32,768
Volume of video information of one frame of video signal window of the second high quality level, bytes	8,192
Volume of video information of one frame of video signal window of the first expanded quality level, bytes	24,576
Volume of video information of one frame of video signal window of the second expanded quality level, bytes	7,680
Volume of video information of the first the second expanded quality level of video image perceived by two eyes of a user, Kbytes	65

Let's determine the maximum traffic of video signals of the first and second high quality levels formed or converted in an urban TV center (Ref. 36) (A6-1/B10-1) on the basis of the fact that the points of vision of all users cover all video image in a regular way.

The volume of video signals of the first and second quality level formed or converted in accordance with method 11 will amount to 15/16 300 = 281 Mbytes/s.

Video signals of such traffic are transmitted to the regional facilities of video signal conversion (Ref. 10) (C1). Boundaries of video image sectors of expanded quality levels are converted in the facility of video signal conversion in accordance with the aggregate interrogation signal used for 100,000 users; in this connection, the aggregate signal traffic is reduced by the value, which mainly depends on the video item and the diversity of the users' reaction. Suppose, that the reduction is equal to 1%.

For the case of the reduction of the video information volume in every sequential level, we may assume, that it is approximated by an exponential function.

The aggregate traffic of video information transmission of the video signal of expanded quality levels for all in-entrance TV channels will be, Mbytes*km/s 1,206,999

- in-building	1,014,317
- in-street	753,960
- in-residential quarter	490,007
- in-region	119,883
- in-town	20,763

The aggregate traffic of video signals of basic and expanded

quality levels and interrogation signals for the proposed method will be, Mbytes*km/s 3,261,902

The aggregate traffic of video information transmission through all data channels of HD TV according to the above calculations will be, Mbytes*km/s 5,508,000

The above value is essentially lower than the traffic of video signal transmission of high definition according to the existing methods.

The above model demonstrates the fulfillment of the stated technical result as an independent method as well as some dependent methods as regards the reduction of the transmission traffic, reduction of the highest stream of video information, compatibility of new TV standards with existing TV standards and data channels, possibility of work at a long distance from the source of video information. Owing to the fact, that restricted volume of information is transmitted through the data channels of lower levels, produced frame are not important for the other users.

According to this example all figures are given for the case when video signal packing as per methods JPEG, MPEG- 1,2,3,4 or any other methods is not used.

Use of video signal packing jointly with the proposed method will result in the reduction of absolute values of the signal streams but will preserve their ratio and advantages of the

proposed method.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

Further, the present application incorporates by reference the following papers, reports and technical disclosures:

1. "An eye and its function", S.V. Kravkov, AS of the USSR, 1950.
2. "Principles of display apparatus configuration in automated systems" I.I. Litvak, B.F. Lomov, I.E. Soloveychik.
3. "Hardware of graphic data input-output" edited by Tchetverikov, series from seven volumes "Organization of a man interaction with hardware of ACS", volume 3.
4. "Work with display Units. Abstract book from the Third International Scientific Conference on Work with Display Units/ 1992"
5. "Cinematographic and TV engineering", 1999, 1
6. Operating procedures of studio cameras and TV-systems in the age of the digital television. Part 2. Camera technique for HD TV. L.J. Torp, Sony corp.
7. "Digital processing of TV and computer images" edited by

Y.B. Zubarev and V.P. Dvorkovich, Moscow, 1997.

8. "Digital TV equipment - Philips Digital Video Systems", V.V. Bykov, journal "Tekhnika kino i televideniya", No. 1 1999.

9. "Operating procedures of studio cameras and TV-systems in the age of digital television. Part II. Operating procedures of cameras for HD TV. L.J. Torp, Businnes and Professional Group, Sony Elektronics Inc., journal "Tekhnika kino i televideniya", No. 1 1999".

10. "Image of super high definition on a huge screen", Eidzo dzeho media gakkay si, 1998, v. 52, No. 7, published in journal Tekhnika kino i televideniya", No. 1 1999".

What is claimed is: